ARS 42-8
February 1957

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Agricultural Engineering Research Branch

A CASTOR BEAN HARVESTER FOR CALIFORNIA

By G. E. Coppock and L. G. Schoenleber, Agricultural Engineers

---

The United States consumes from 40 to 50 percent of the world's castor bean production, yet produces less than 3 percent of its needs. Castor oil, which is extracted from the castor seed, is used in many products for both military and civilian purposes such as lubricating oils, paints and plastics.

The castor bean plant is grown primarily for its seed which contains about 50 percent oil. The seeds grow inside capsules which form clusters on spikes attached to the plant.

Plant breeders have developed varieties during the past few years well adapted to production under irrigation in the Southwest, but the lack of an efficient mechanical harvester has been the principle factor in limiting production in this area.

Realizing the need for a castor bean harvester, the U. S. Department of Agriculture, the Kern County Land Company, and the Hopper Machine Works of Bakersfield, Calif., initiated a program in the spring of 1956 to develop a castor bean harvester for the irrigated sections of California. Many of the principles used in this harvester are the results of several years of agricultural engineering research and development by the U. S. Department of Agriculture and various other public and private research agencies. Some of these principles were improved or altered to adapt them to California conditions.

The purpose of this report is to describe the harvester and its performance under field conditions. The machine was built during the summer of 1956 and put into the field in September and operated at intervals throughout the season.

DESCRIPTION AND OPERATIONS OF HARVESTER

The harvester is a self-propelled unit powered by two industrial type engines and is designed to harvest two rows planted 38 inches apart. One engine propels the machine and the other drives the harvesting mechanism. Power is transmitted through hydraulic motors to all harvesting components except the huller which is driven mechanically. The carriage,

header, scalpers, huller-cleaner, and storage bin are the primary components of the harvester. Their position on the machine may be seen in figure 1.

Carriage -- A specially designed carriage with a front axle clearance of 6 feet is used to carry the harvesting mechanism. This design permits the upright passage of plants through the header. The principle is shown in figure 2. A separate engine with a four speed gear box is used to power the carriage. By use of the four forward gears and the engine throttle the ground speed can be varied from 0.75 to 12 mph.

Header -- The header is made up of a cage equipped with oscillating brush type horizontal seals, collecting augers, inclined drag elevators, and rotating knocker assembly. The position of these components is shown in figure 3. The primary function of the header is to remove and collect the capsules from the plants. As the machine moves forward on the rows, the base of the stalk passes between the oscillating brushes which form a horizontal seal. The rotating knockers hit the stalk about 10 inches above the ground, which produces a low frequency vibration in the stalk causing the capsules to drop from the plant. The stalks pass through a vertical seal at the rear part of the cage and out under the machine. The capsules drop onto the oscillating nylon brushes which move them into the collecting augers mounted along each side of the row. These augers convey the capsule along with varying amounts of leaves and broken branches toward the rear of the cage and discharge them into drag flight elevators which are attached to the discharge end of the augers. The elevators move the material onto the scalpers.

Scalpers -- The capsules are conveniently removed from the leaves and the plant branches by the scalpers which consist of an oscillating screen and a collecting auger. A scalper is provided for each row as shown in figure 4. The scalpers are specially designed to permit only the capsules to fall through the screen and to oscillate at sufficient speed to move the leaves and plant branches off the screen. Capsules, which pass through the screen, fall into a collecting auger which in combination with a flight elevator moves them to the huller.

Huller-Cleaner -- The hulls are removed from the castor seed in the huller-cleaner which includes a hulling unit consisting of two horizontal adjacent rubber-faced discs 24 inches in diameter, and a cleaning unit made up of a suction fan and a cleaning chamber. These components are built into one compact unit shown in figure 5. This unit is located directly under the operator's platform. In the hulling unit, the top disc is stationary and the bottom one rotates. The capsules pass between these two discs which break them into segments and loosen the hulls from the castor seed. The loose hulls and the castor seed pass into the cleaning unit which separates the hulls from the seed and discharges the hulls to the ground. Clean seed drop out of the cleaning chamber by gravity into

a cup-type elevator which elevates and discharges the seed into a horizontal auger. This auger delivers the beans to a tank.

Storage Bin -- A one-ton capacity storage bin is provided on the machine. The clean seeds are delivered to the bin by an auger which also serves to level the seed in the bin. By use of two hydraulic cylinders attached to the bin, the seeds are dumped from the bin into a truck or trailer as shown in figure 4.

ADJUSTMENTS

Five adjustments are provided to adapt the machine to varying field conditions. They include the knocker disc speed, header height, ground speed, huller disc spacing, and air discharge outlet on huller. The knocker disc is adjusted to a speed just fast enough so that the knocker removes all the capsules from the plant. Excessive knocker speeds increase the stalk breakage which puts an additional load on the cleaning system. The header cage is adjusted as low to the ground as possible without causing it to drag. The rate of harvesting is determined by the ground speed of the harvester. The forward travel of the harvester is adjusted to a speed which will not cause overloading of the cleaning system or cause excessive loss of castor seed by dividing too quickly those plants which overlap between the rows. The space between the hulling discs is varied until they hull as many capsule segments as possible without excessive seed breakage. Broken seeds are lighter in weight than whole seed and are difficult to separate from the hulls. The air control in the discharge outlet from the cleaning fan on the huller is varied until good separation of the hulls from the castor seed is obtained.

PERFORMANCE

Extensive field tests were made of the harvester in the fall of 1956 near Bakersfield, Calif., on defoliated castor beans of the Pacific 6 variety which varied in height from 3 to 12 feet. Views of the harvester in operation are shown in figures 6 and 7. Average yields of castor beans harvested varied from 2,000 to 3,500 lbs. per acre. The machine was operated at intervals between September 15 and November 15 during which time it harvested approximately 150 acres. Some changes were made on the machine during this period to improve its performance. The rigidity and strength of the framing, the performance of the power transmission system, and the power of the engines proved adequate under all field conditions. The mechanical trouble encountered was minor.

Harvesting losses varied from 5 to 10 percent[1/] depending upon plant height, condition of capsules, yield, cultural practices, and skill in operation of the machine. Harvest losses were greater for tall plants than short ones. Moisture in the stalks and beans due to relative humidity above 45 percent reduced the efficiency of the knockers and the

1/ Results of tests conducted by the University of California.

huller-cleaner. An effective job of defoliation increased the efficiency of the knockers and the huller-cleaner. The percent harvest loss decreased as the yield increased provided the plant characteristics were the same. Fields with soil ridged or rounded on rows permitted the harvester header to operate with brush seals below the lowest castor bean spike thus saving more capsules.

The machine harvested castor beans yielding 3,000 lbs. per acre without difficulty at 2 to 2-1/2 miles per hour. The huller-cleaner was the main factor limiting the harvesting time and rate. Green or damp capsules as well as excessive trash reduced the huller-cleaner capacity. At harvest rates above 5,000 lbs. per hour, some hulls and sticks passed through the huller-cleaner with the castor seed. Under most conditions a satisfactory harvest job was obtained at a harvest rate of 1-1/4 acres per hour. This included turning at row ends and unloading.

The harvest was delayed approximately 8 days during the test period because of rain. During the 1956 harvest season it was estimated that the machine could have operated the following number of days in good weather: September - 15 days at 8 hours per day, October - 22 days at 7 hours per day, and November - 15 days at 6 hours per day.

RECOMMENDED PRACTICES FOR MECHANICAL HARVESTING

1. Use recommended varieties.

2. Plant seed on 12 inch spacing in row.

3. Space rows at 38 inches.

4. Last cultivation should be such that the castor bean plants are left on a medium sized round or oval-shaped bed.

5. Middles between rows should be center-furrowed to facilitate accurate driving of the machine.

6. Begin harvesting early enough in the fall so that harvest can be completed before damp weather begins.

7. Harvest only when castor beans are dry so that the beans will be in condition for hulling.

8. Use a chemical defoliant which will cause the leaves to drop and kill the green capsules. Allow enough time after defoliating for the green capsules to dry (10-15 days).

9. Level a 25-foot turn row at both ends of field to facilitate turning and unloading of the harvester.

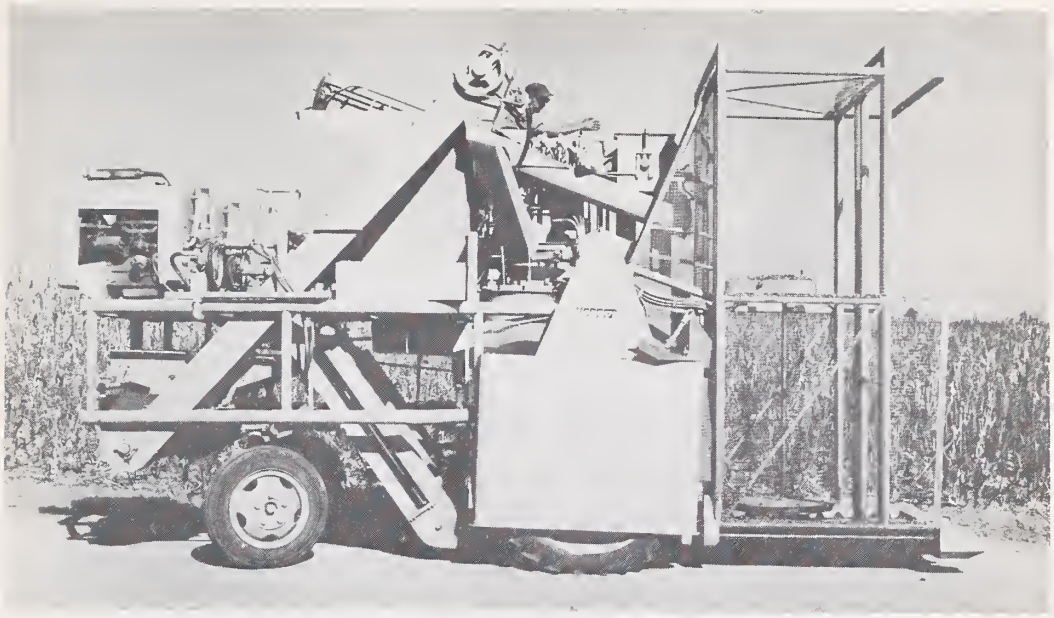

Figure 1. Side view of harvester showing the carriage header, scalpers, huller, and connecting elevators.

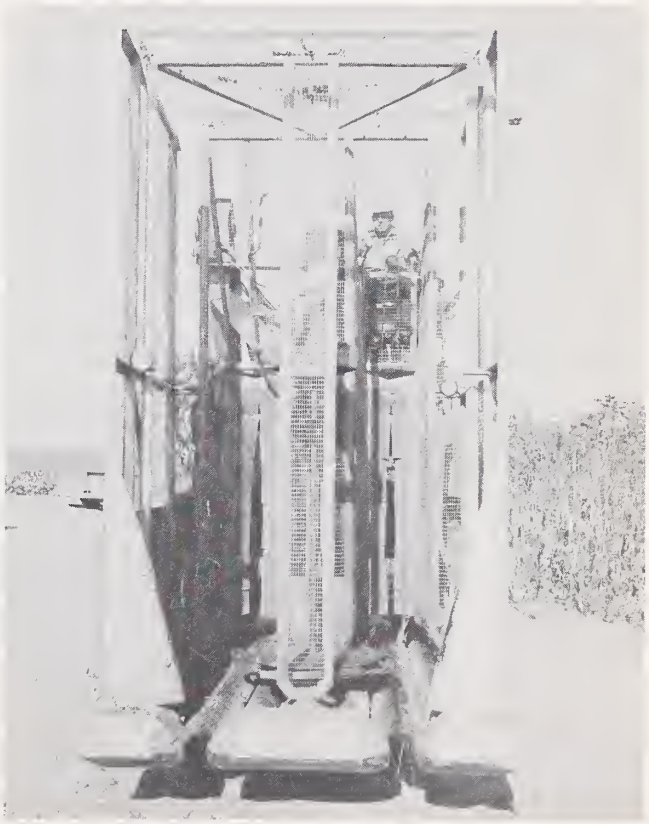

Figure 2. Front view of harvester showing the high clearance principle to permit the upright passage of plants through the header.

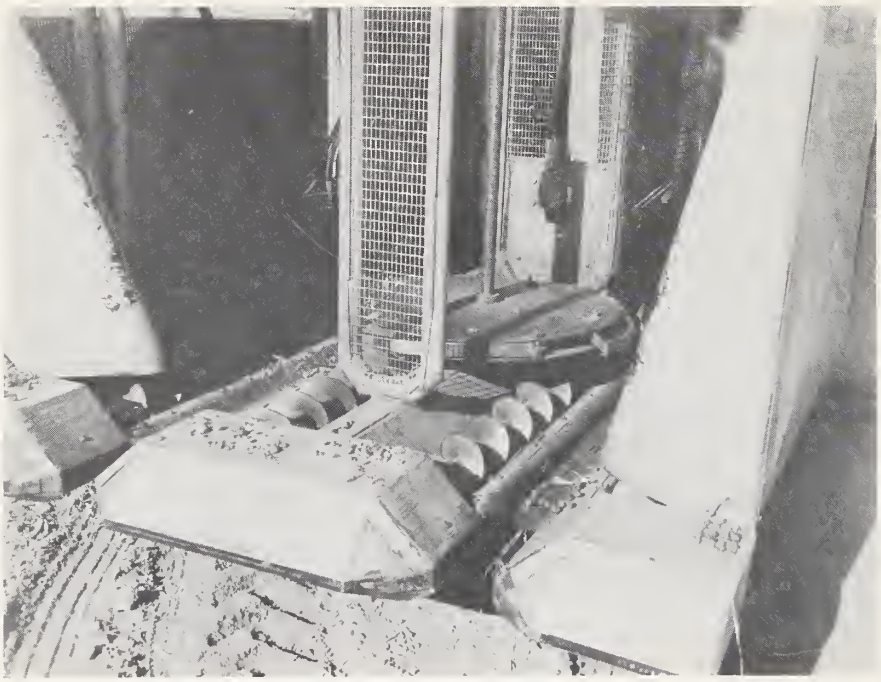

Figure 3. View of header showing the cage, horizontal brush seal, collecting augers and rotating knockers.

Figure 4. Rear view of harvester showing the location of the two scalpers and the bin in unloading position.

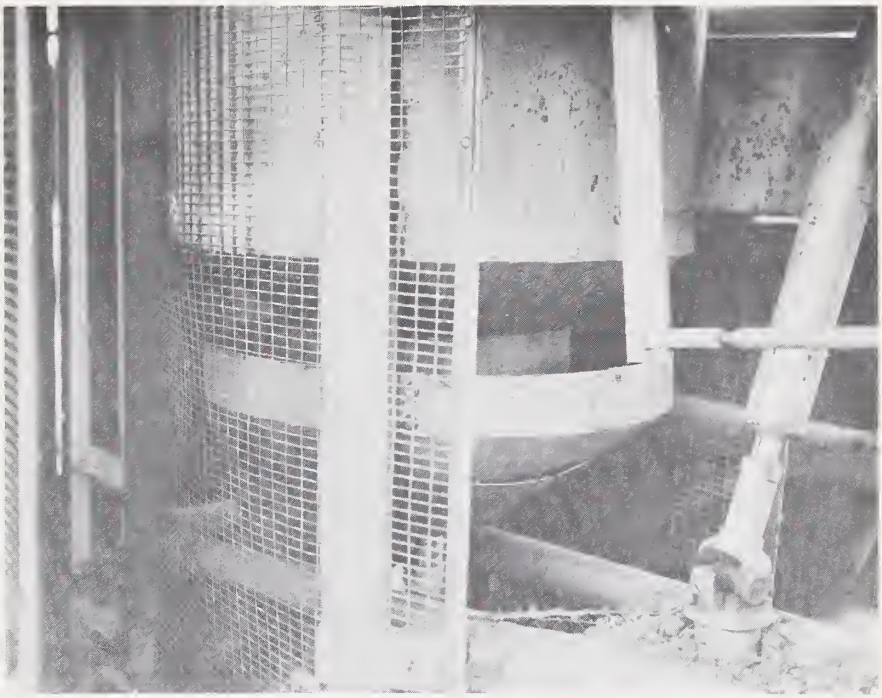

Figure 5. View showing the huller-cleaner mounted on harvester.

Figure 6. Harvester operating in field.

Figure 7. View of a field of tall castor beans after harvester has passed by.

From: Harvesting and Farm Processing
Research Branch, AERD, ARS, USDA